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SOME CALIFORNIA WILDLIFE-FOREST RELATIONSHIPS 1/

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EFFECTS OF FOREST-WILDLIFE INTERACTIONS

Forests, with their diversity of conditions, are the homes of numerous forms of wildlife. They are, indeed, communities of interrelated living organisms. The lives of the forest plants and animals are so closely interwoven that it is impossible for one of them to function without influencing others. These interactions largely determine the nature of the biotic community.

The animals in any community depend, directly or indirectly, upon plants for food and, in many instances, for shelter. The type of vegetation available for food and cover determines, in part, the species of animals that can exist on an area. All animals display preferences, in these respects, that may or may not prevail to an exclusive extent. The results are twofold: (1) If an animal is unadaptable to a given environment and requires a definite type of food or cover, plants may be an important factor in determining its abundance and distribution. In such circumstances there will be a somewhat constant ratio between the abundance of host plants and that of guest animals, though over a long period of time the numbers of both may fluctuate greatly. (2) If the animal is highly adaptable, changing readily from one food to another and maintaining its numbers, it is likely to exert a marked influence upon the plant community.

1/ Revised from paper presented at the Third North American Wildlife Conference, Baltimore, Md., February, 1938 (Trans., pp. 376-380, 1938).

TYPE OF FOREST AFFECTS WILDLIFE

Compared with other parts of a dense forest, the floor is practically devoid of animal life. Few animals can utilize it for a permanent home. Food is scarce, and shelter is scant. On such a forest the only forms present in any abundance are those capable of arboreal life. Chickadees (Penthestes), nuthatches (Sitta), pine squirrels (Tamiasciurus), gray squirrels (Sciurus), and a few chipmunks (Eutamias) frequent the treetops. The more-open forests, as those of the ponderosa pine (Pinus ponderosa) of the West, are more hospitable to wildlife. Except in dense reproduction thickets, the trees are so spaced that some light reaches the forest floor. Grasses and herbaceous vegetation thrive in proportion to the openness of the canopy. Here small rodents exist in somewhat greater abundance, and birds and the larger mammals, including the fur bearers and deer, in notably larger numbers. The sugar pine-fir type of the Sierra Nevadas seems intermediate in wildlife carrying capacity. In this kind of forest in California, sugar pine (Pinus lambertiana) is not reproducing on many large areas. Instead, white fir (Abies concolor) and incense cedar (Libocedrus decurrens) predominate in the reproduction.

On any forest, disturbances of catastrophic proportions, as burning or cutting, cause abrupt changes in the biotic community. This was observed in California forests. Following logging on the sugar pine-fir type, the ground cover increased rapidly. Herbaceous species, as grasses, shrubs, and especially bur-clover (Chamaebatia foliolosa), grew abundantly, the bur-clover forming a tenacious mat on the ground. The habitat was vastly improved for small rodents and mice (Peromyscus sp. and Microtus mordax), and chipmunks increased from 10 to 50 fold.

As such an area grows up to browse species, deer (Odocoileus hemionus) find it suitable for summer pasture. Winter range of deer in this area is more of a restrictive factor than summer range, and management that produces additional summer range should also provide the supplementary winter range that will inevitably be needed. In a few years, many of the cut-over areas support a large population of Beechey ground squirrels (Citellus beecheyi beecheyi). The statement is often made that this species is extending its range to higher elevations. In the Stanislaus National Forest, Calif., these squirrels did increase on cut-over areas, either by migration to a habitat made suitable for occupancy by the cutting, or by the breeding of relict populations. In either event, the result was a noticeable increase in this highly adaptable rodent. Because the Beechey ground squirrel is food for certain predators, its increase may be followed by enlargement of the population of the carnivores, especially when other habitat factors are favorable.

WILDLIFE AFFECTS TYPE OF FOREST

Rodents, especially mice and chipmunks, show a decided preference for seeds of some pines, and studies show that among those produced in the California forests the preference was in the following order: Sugar, Jeffrey (*Pinus jeffreyi*), and ponderosa pines, and after these, white fir and incense cedar. The last named is eaten in small quantities. Though the preference was in the order of seed size, that is not the deciding factor, as the relative acceptability was the same when the seeds were reduced to a paste by grinding. Possibly the chemical composition of the seed may play an important part.

Cutting decreases the supply of sugar pine seed, and the utilization of the seeds by rodents is high. As a result, nearly all the seeds are taken each year. The few that are left to germinate find severe and often fatal competition with bur-clover and other plants that increased so markedly after logging operations.

As white fir seed is abundant and only partially consumed by rodents, it reproduces far more readily than does the sugar pine. Incense cedar seed is eaten in small quantities by rodents and reproduces well. As a result of these conditions the sugar pine is not regenerating and is being replaced by the less commercially valuable white fir and incense cedar. Apparently regeneration of the sugar pine occurs only at widely separated periods. Probably reproduction is the result of coincidence of a heavy seed crop and a low seed-eating animal population in a year followed by conditions suitable for germination of seedlings.

Farrow, in his work on rabbits in England, found good indications that these animals have been responsible for the change of many areas from forest to grassland. There is a strong possibility, likewise, that in California some sugar pine-fir-incense cedar associations may give way to fir-cedar because of activities of seed-eating rodents.

RESULTS ON CALIFORNIA STUDY AREAS

The effects of changes in forest composition are far reaching. Opening forests by burning or cutting increases food and shelter for many animals. Shrubs valuable for deer food thrive, more edges are created, and the deer increase. In 1924, during the outbreak of foot-and-mouth disease, 22,000 deer were killed in one of the efforts to stamp out the malady. Before and after the deer were killed, lumbering opened large portions of the forest, so that the habitat became very favorable. Despite local extirpation, deer are again abundant, and there is a possibility that the summer range has a carrying capacity in excess of that of the winter range. If this proves true, over-grazing of the winter range will follow. As the cut-over areas grow up to forest trees, conditions for deer on the summer range also will become less favorable. Good browse species may then show the effects of over-grazing and finally disappear. The seed-eating rodents, by limiting sugar pine reproduction and permitting relative in-

crease of fir and cedar, may contribute to a more closed forest that will be disastrous to the deer population. The proper ratio of summer to winter range could be regulated, however, by continued logging and opening of timber areas.

A thousand-acre experimental burn on the Lassen National Forest, Calif., had the following effects upon wildlife:

1. Deer left the area before the fire and returned in increasing numbers the year after, attracted, no doubt, by new sprouting shrubs and increased annual vegetation.

2. All rabbits, chiefly cottontails (*Sylvilagus*), were killed, or the few survivors moved off immediately after the fire. Many carcasses were found.

3. Chipmunks were markedly reduced but not extirpated. Breeding stocks survived in some of the rocky outcroppings.

4. Mice of the genus *Peromyscus*, although markedly reduced in numbers, survived the hottest fire. This was indicated by the fact that 2 days after the fire, adults and their litters of young were caught in traps in the center of the burned area. Doubtless these mice escaped the heat by going into deeper burrows.

After the fire, two generations of young *Peromyscus* were produced, thus augmenting the population of these seed-eating rodents. There was a good seed crop of ponderosa, Jeffrey, and even sugar pine, and seed was well scattered over the burn. Mice were numerous enough, however, to pick up most of the seed, so that only a small quantity remained to germinate. Brush of the kinds that ordinarily follow fire (*Arctostaphylos*, *Ceanothus*, and *Prunus*) has made good growth, producing competition for the conifer seedlings. If this growth continues it will result in dense growth favorable to timber production but of limited value to game. Seed consumption by rodents greatly reduces the number of seedlings that might spring up on brushfields after a burn.

Burns discourage rabbits for several years. Perhaps lack of protective cover is the factor responsible, for the rabbit-food supply is improved in quality, quantity, and diversity by the burns. In 1935 a small experimental burn was immediately planted to ponderosa pine, using the forester's 1-1 stock, and an adjoining unburned area also was planted. Rabbits clipped 68 percent of the plants on the green brush area and only 23 percent on the burned area. In the spring of 1937 the areas were interplanted, and the results in clipped seedlings were 16 percent on the burned area and 61 percent on the green brush area. In many sections of the California pine forests, rabbits cause considerable damage to seedlings and planted stock of pine by cutting off and eating the young trees. Some seedlings are killed, while others are retarded in growth, the terminal bud being taken out, following which, in time, one of the laterals becomes

the leader. Recovery from repeated clipping by rabbits produces badly deformed, bushy trees. Much of this damage can be avoided by planting burned areas the first season following the burn.

As noted, the opening of large forest areas by either burning or cutting results in an increased population of small rodents. These provide quarry for predatory birds and mammals, which then may also increase. Subsequent depredations of some of these predators on game species is only incidental, but the incidence of game in their food is greater as their numbers increase. The rodents, as buffer species, serving as a staple food supply for the predators, act to increase the predator population and therefore the predation on certain game species. Whether this increased predation is serious depends upon whether the game-predator ratio is altered.

The response of animals to habitat changes makes it possible to increase desired species by proper management. If the habitat is made more suitable, wildlife increases, and conversely, if less suitable, wildlife decreases. Response varies in proportion not only to habitat change but also to animal adaptability. It is possible to take advantage of these relations to bring about ecological control of certain undesirable species of animals. Even here the ability of the animal to meet altered conditions will determine whether the practice is feasible and compatible with other uses of the land area. For example, burning of the Manzanita-Ceanothus brushfields of northern California discourages rabbits and thus cuts down the loss of planted pine stock. It results, also, in an increase of seed-eating mice and tends to prevent natural pine regeneration.

Forest-management planning also should consider less conspicuous but equally far-reaching ecological relationships, so that the greatest uses can be made of both the forest and the wildlife resources.

